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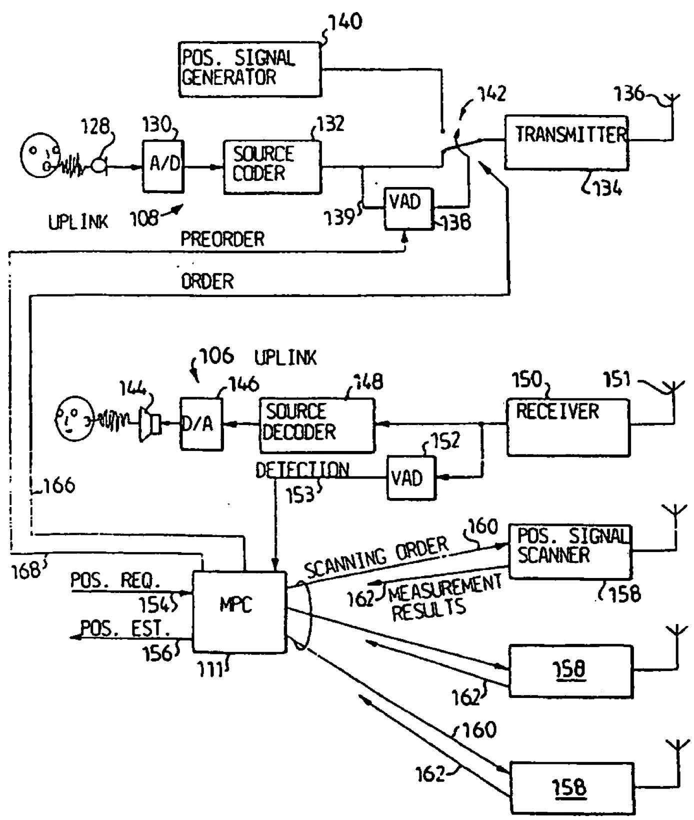
(54) Title: A METHOD FOR POSITIONING AND AN APPARATUS IN A CELLULAR COMMUNICATIONS SYSTEM

(57) Abstract

In a wireless communication system including a number of base stations (102, 104, 106) for serving mobile stations (108) present in the system, the position of a mobile station during a voice call in progress is determined by performing time or angle measurements using a positioning signal between the mobile station and a required number of the base stations. Means (138, 152) are provided for detecting voice activity in the voice call in progress, and further means (111, 138, 152, 142) are provided for voice synchronizing the transmission of the positioning signal with a part of the voice call in progress having low or lacking voice activity.



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A METHOD FOR POSITIONING AND AN APPARATUS IN A CELLULAR COMMUNICATIONS SYSTEM

Technical Field of the Invention.

In a cellular communications system the position of a mobile station is conventionally determined based on time measurements between the mobile station and a number of base stations, the signal times in turn being used to derive distances. The time measurements can be made on uplink, i.e. base station measurements of transmissions from a mobile station, on downlink, i.e. mobile station measurements of transmissions from a base station, or both.

Description of Related Art.

Methods for locating a mobile station are described in:

Motorola, "Location Power Up Function (Traffic Channel)", Doc. TR45.5.2.3/97.07.14.07, TIA TR45.5, Milwaukee, WI, July 14-18, 1997.

Motorola, "Mobile Station Location using Power Up Function", Tdoc SMG2 UMTS A36/97, ETSI SMG2 Wideband CDMA Concept Group, Stockholm September 15-17, 1997.

US patent application No 08/935421, "Method and Arrangement Relating to Position Determination in Cellular Mobile Radio Systems".

EP 749 256 discloses a system for localizing a most preferable base station as seen from a mobile station, i.e. the detection is performed on downlink. The control channels of adjacent base stations are detected for judging signal strength. When the control channel of an adjacent base station appears simultaneously with the current speech channel of the mobile, detection is performed in the speech time slots assigned to the mobile, when there is no speech.

WO 97/30360 discloses a system for determining the position of a mobile station by receiving a signal from several different unsynchronized base stations.

A similar system is disclosed by WO 96/31076.

Summary.

When time measurement is performed on an uplink signal during a call in progress, it is desirable to use the existing uplink signal to do the time measurement. However, the existing uplink signal is normally designed for communication with one or a few serving BSs and it may therefore be difficult for other BSs to perceive such an uplink signal.

To improve the ability of non-serving BSs to hear the MS, a specific uplink signal can be used, that the MS only needs to transmit for a limited time until a required number of BSs have made their time measurements. This signal, being used to be referred to as the uplink positioning pulse, or UPP, may be new, i.e. specifically designed for the purpose, or be an existing signal that is also used for other purposes.

As examples of UPP there can be mentioned:

In IS-95-B there has been defined an uplink signal called PUF (Power Up Function).

In GSM, one may consider to make the MS send a number of access bursts by performing an intra-cell HO.

The advantage of using a new UPP is that it can be designed for positioning requirements, e.g. the ability to be heard from an adequate number of base stations. For example, the power can be increased. If the UPP is based on an existing signal, one can choose a signal that best fulfills the positioning requirement.

It is undesirable, and in some cases not possible, to transmit the UPP simultaneously with the regular uplink communication signal in the traffic channel. During a voice call in progress, the voice will therefore need to be disrupted in the uplink direction during the UPP transmission.

This problem is mostly related to positioning taking place during a voice call. If positioning is required at call set-up, e.g., for emergency calls, it may be preferred to order the MS to send an UPP before call is through-connected to the destination. This will ensure a timely UPP with no voice disruption.

There is an object of the invention to provide a solution to the above discussed problem.

In a wireless communication system including a number of base stations for serving mobile stations present in the system, the position of a mobile station during a voice call in progress is determined by performing time or angle measurements using a positioning signal between the mobile station and a required number of the base stations. Voice activity in the voice call in progress is detected and, according to the invention, the transmission of the positioning signal is voice synchronized with a part of the voice call in progress having low or lacking voice activity.

During normal conversation, the voice in one direction is only active during part of the time. By synchronizing, in accordance with the invention, the transmission of the positioning signal to a period when there is no or low voice activity, the disruption will cause very little loss of information, i.e., the voice disruption will be negligible.

In a preferred embodiment a triggering point will be defined and detected for the transmission of the positioning signal.

In case the positioning signal is sent uplink, the triggering point may be chosen to be either an uplink voice activity transition point in which the upplink voice becomes inactive, or a downlink voice activity transition point in which the downlink voice becomes active.

In case the positioning signal is sent downlink, the triggering point may be chosen to be either a downlink voice activity transition point in which the downlink voice becomes inactive, or an uplink voice activity transition point in which the uplink voice becomes active.

According to an alternative embodiment, the one of the uplink voice activity transition point and the downlink voice activity transition point that comes first may be defined and detected as the triggering point.

Transmittance of the positioning signal may either be ordered after the triggering point has been detected, or be

pre-ordered, before appearance of the triggering point, to be performed a specified time after the appearance of the triggering point. The specified time should be chosen to be enough to admit ordering to listen for the positioning signal to enable catching of it when it appears.

According to a further embodiment a number of base stations may first be ordered to listen for the positioning signal and then the mobile station will be ordered to transmit the positioning signal.

According to still a further embodiment the uplink positioning signal may be transmitted immediately if the uplink voice is inactive.

Brief Description of the Drawings.

The invention will now be described more closely with reference to the enlosed drawings on which

Fig. 1a is a schematic view of a part of a wireless communication system which includes base stations and mobile stations,

Fig. 1b is a schematic system view including some of the elements of Fig. 1a and intended to illustrate the interaction of some essential functionalities in connection with realization of the invention,

Fig. 2 is a diagram illustrating a first case of voice activity and positioning signal transmission during downlink and uplink communication between a mobil station and a base station.

Fig. 3 is a diagram illustrating a second case of voice activity and positioning signal transmission during downlink and uplink communication between a mobile station and a base station.

Fig. 4 is a diagram illustrating a first main embodiment for triggering transmission of a positioning signal,

Fig. 5 is a diagram illustrating a first sub-alternative for utilizing a trigger point for triggering transmission of a positioning signal,

Fig. 6 is a diagram illustrating a second sub-alternative

for utilizing a trigger point for triggering transmission of a positioning signal,

Fig. 7 is a diagram illustrating a second main embodiment for triggering transmission of a positioning signal.

Detailed description of Embodiments.

Fig. 1a is a schematic view of a part of a wireless communication system which includes a number of base stations for serving mobile stations present in the system. Only by way of example, said part is indicated to include three base stations 102, 104 and 106, and a mobile station 108. System infrastructure, exemplified in Fig. 1a by a switch, is indicated at 110. A mobile positioning center (MPC) is indicated at 111 to be associated with the switch 110. The base stations 102, 104 and 106 are able to communicate with the switch 110, as indicated by double arrows 112, 114 and 116, respectively.

Arrows 118, 120 and 122 between the mobile station 108, on the one hand, and each of the base stations 102, 104 and 106, respectively, on the other hand, represent transmission of positioning signals therebetween. To indicate the possibility to send positioning signals either from the mobile station 108 or from the base stations 102, 104 and 106, the arrows 118, 120 and 122 are shown as double arrows.

Uplink and downlink communication between the mobile station 108 and the base station 106, by way of example, is indicated by arrows 124 and 126, respectively.

There are a number of methods to perform positioning of a mobile station user in a wireless communication system. A category of methods of interest here is to perform time measurements between the mobile station and a number of base stations while using positioning signals. One such time measurement method can be time of arrival measurement, used to be referred to as TOA (Time Of Arrival), for the positioning signals either at the mobile station, as e.g. represented by the mobile station 108, or at the base stations, as e.g. represented by the base stations 102, 104 and 106. Another

such time measurement method can be measurements of difference in time, used to be referred to as TDOA (Time Difference Of Arrival), for the positioning signals either at the mobile station, as represented by the mobile station 108, or at the base stations, as e.g represented by the base stations 102, 104 and 106. A further such time measurement method can be a combination of TOA and TDOA measurements.

Still a further method is based upon using the positioning signal for measuring bearing. This method is used to be referred to as AOA (Angle Of Arrival). In this case there is thus not the question of time measurement, but an advanced antenna system in the base station is used to determine the angle to the signal source.

From the above discussed measurements, i.e. the TOA, TDOA and AOA methods, it will be possible to find the most likely position of the mobile station by using triangulation or more advanced known methods.

The position of the mobile station 108 during a voice call in progress is thus possible to determine by performing time or angle measurements between the mobile station 108 and a required number of base stations, in the present case represented by the base stations 102, 104 and 106.

In the further description below of embodiments with reference to the drawings a main presumption will be, for the sake of simplicity, that the positioning signal is transmitted uplink. In other words, it will be the mobile station 108 that transmits a positioning signal covering inter alia the directions indicated by arrows 118, 120 and 122 so as to admit interception by the base stations 102, 104 and 106. How to convert the described method to the downlink case will, however, be described in short as well.

Referring also to Fig. 1b in connection with Fig. 1a, the interaction of some essential functionalities in connection with performing the method according to the invention will now be described. The respective uplink portions of the mobile station 108 and a base station, here supposed to be the base station 106, are here indicated by arrows 108_{uplink} and 106_{uplink},

respectively.

Conventionally, the mobile station uplink portion 108_{uplink} may inter alia comprise a microphone 128, an A/D converter 130, a source coder 132, a transmitter 134 and a transmitting antenna 136. A voice activity detector 138 is shown by arrow 139 to detect voice activity on the output of the source coder 132. As will appear from the discussions following below, the voice activity detector 138 can form part of the switch 110 or the base station 106. It can be of a kind known per se for use in wireless communication systems. Below it will be referred to as VAD.

The VAD 138 may be used for voice synchronizing, in accordance with the invention, the transmission of a positioning signal, obtained from a positioning signal generator 140, with a part of a voice call in progress on the uplink lacking voice activity. More particularly, said voice synchronizing is schematically indicated as performed through a switching function indicated by arrow 142. The switching function 142 is controlled by the voice activity detection of the VAD 138 for switching over a relevant one of the outputs of the source decoder 132 and the positioning signal generator 140 to the transmitter 134. This process will be described in greater detail below.

Likewise conventionally, the base station uplink portion 106_{uplink} may inter alia comprise an earphone 144, a D/A converter 146, a source decoder 148, a receiver 150 and a receiving antenna 151. To the output of the receiver 150 a further VAD 152 is indicated to be connected. Also the VAD 152 may be used for voice synchronizing, in accordance with the invention, the transmission of a positioning signal, obtained from the positioning signal generator 140, with a part of a voice call in progress lacking voice activity as will be described more closely below. Detection by the VAD 152 of speech activity, or inactivity, is reported to the MPC 111 as indicated by arrow 153. As will also be described, embodiments of the invention may imply using any single one of the VADs 138 and 152, or both in combination. Also the VAD 152 may form

part of either the network 110 or the base station 106.

Further indicated in Fig. 1b is the MPC 111. The MPC 111 receives positioning requests, indicated by an arrow 154, and returns information regarding an established position, indicated by an arrow 156. The MPC 111 furthermore communicates with base stations, such as the base stations 102, 104, 106 which each have a positioning signal scanner indicated by block 158.

More particularly, the MPC 111 on having received a positioning request 154 transmits scanning orders, indicated by arrows 160, to the base stations in question. Having performed the requested scanning, the base stations return respective measurement results, indicated by arrows 162. The MPC 111 processes the measurement results 162 in order to establish the requested position, and forwards the result of the processing as indicated by arrow 156. The MPC 111 furthermore communicates with the mobile station 108 as will be described more closely below.

Fig. 2 is a diagram illustrating, with the aid of four time axes 202, 204, 206 and 208 covering the same period of time, voice activity and positioning signal transmission in the traffic channel during downlink and uplink communication between the mobile station 108 and the base station 106. More particularly, the time axis 202 is used for illustrating downlink communication, a downlink speech spurt being indicated at 210 as an example. The time axis 204 is used for illustrating uplink communication, two uplink speech spurts being indicated at 212 and 214 by way of example.

As can be seen, the uplink speech spurts 212 and 214 in this case appear before and after, respectively, the down link speech spurt 210, as could normally be expected. In other words, the down link voice activity 210 in the traffic channel occurs between two appearances 212 and 214 of uplink speech activity in the case shown. Double arrow 216 indicates speech cycle time.

The time axis 206 is a generalized version of the uplink communication axis 204, the two speech spurts being indicated

by blocks 212′ and 214′. Arrows 218 and 220 indicate time duration of the speech spurt 212 and the time duration of the pause between the speech spurts 212 and 214, respectively.

The time axis 208 is used for illustrating positioning signal transmission from the mobile station 108, a positioning pulse being indicated at 222 by way of example. According to the present invention as described schematically above with respect to Fig. 1b, the transmission of the positioning pulse 222 is synchronized to voice activity to a period when there is no uplink voice activity in the traffic channel as indicated by the VAD 138. As is also illustrated very schematically by Fig. 2, said synchronizing is somewhere in the pause between the two speech spurts 212 and 214. The reason for and significance of this will be dealt with in greater detail below.

The synchronizing to voice activity can be achieved in a number of ways, which can be based on a VAD as indicated above. A VAD indicates the degree of voice activity in a specific direction, e.g. whether the speech is active or inactive. As will be described further below, and returning to Fig. 1a, some embodiments of the invention may require a VAD associated with the switch 110 and/or the mobile station 108, and/or the base stations 102, 104 and 106.

Generally, a VAD can be used to analyze the on-going speech to decide the level of voice activity. In ETSI/TC SMG, Recommendation GSM 06.32, "Voice Activity Detection" use of a VAD has for example been proposed for deciding when to enable discontinous transmission, usually referred to as DTX, from a mobile station in order to save battery power. In TIA/EIA/IS-96-B, "Speech Service Option Standard for Wideband Spread Spectrum Systems" a more advanced VAD has been proposed that determines which information rate to use from a fixed set of four different rates. DTX could be viewed as the extreme where only two rates exist, one high rate for active speech and one low rate when the speech is inactive and only noise needs to be transmitted.

Below embodiments of methods for voice synchronizing

transmission of the positioning signal will be described with further reference to Figs. 3-8 and based upon what has been described with reference to Figs. 1a, 1b and 2.

Fig. 3 is a diagram illustrating voice activity and positioning signal transmission in the traffic channel during downlink and uplink communication between the mobile station 108 and the base station 106. More particularly, the time axis 302 is used for illustrating downlink communication, a down link speech spurt appearing in the base station receiver 150 being indicated at 310 as an example. The time axis 304 is used for illustrating uplink communication, two uplink speech spurts appearing at the output of the source coder 132 being indicated at 312 and 314 by way of example.

As can be seen, the downlink speech spurt 310 here starts some time before the uplink speech spurt 312 ends, thus causing double talk, as indicated by double arrow 315.

On each of the time axes 306 and 308 a positioning signal pulse 316 and 318, respectively, is indicated, such as obtained from the positioning pulse generator 140. The pulse 316 starts a time t_1 after the end of the uplink speech spurt 312, and the pulse 318 starts a time t_2 after the start of the downlink speech spurt 310.

Generally, in accordance with a first main embodiment, a defined voice activity transition point, referred to below as "trigger point", is used to trigger transmission of the positioning signal. As earlier described the transmission proper is performed by the switching function 142 as controlled by the VAD 138 and/or 152. The trigger point need not coincide with the point of transmission for the positioning pulse. As an example, Fig. 4 illustrates this by indicating trigger points by arrows 402, 404 and 406 along a time axis 408. An arrow 410 indicates the appearance of a positioning request, as received by the MPC 111 according to arrow 154 in Fig. 1b, at time t_{posreq} along the same time axis. Suppose e.g. that the trigger points 402, 404 and 406 indicate points of time at which the uplink voice becomes inactive, as detected by the VAD 138, and that the positioning request 154

appears during the presence of a speech spurt 412 that is ended by the voice activity transition point 404. Then sending of a positioning signal will be trigged at the time indicated by arrow 404.

To avoid undue delays, a time-out value can be used in the VAD 138 to set a maximum delay, at which time the positioning signal is sent anyway. Sending after such a delay may cause disrupture of a still active uplink. Suppose e.g. that such a time-out value would be used in the case of Fig. 4 and that it appeared as $t_{timeout}$ at the point of time indicated by arrow 414, thus setting the maximum delay to end at this point of time, before the voice activity transition time 404. Then, the positioning signal would be sent at the point of time indicated by the arrow 414, causing an interruption in the speech spurt 412.

The trigger point can be defined according to different alternatives.

A first main alternative to define the trigger point is to use the transition when the uplink voice becomes inactive, as the end of the speech spurt 312 in Fig. 3, or in the case illustrated in Fig. 4. This method requires an uplink VAD 152 to be implemented in the switch 110 or the base station 106. The trigger point can be utilized according to two sub-alternatives, referred to as sub-alternatives a) and b) below, and schematically illustrated by Figs. 5 and 6, respectively.

According to sub-alternative a) and referring to Figs. 1b and 5, the MPC 111 upon having awaited the VAD 152 to trigg due to uplink speech becoming inactive, first orders, as indicated by the arrows 160, at a point of time $t_{orderBS}$ indicated by arrow 502 along a time axis 504, a number of base stations, such as base stations 102, 104 and 106, to listen for the positioning signal. Then the MPC 111 orders, as indicated by arrow 166 in Fig. 1b, at a point of time $t_{orderMS}$ indicated by arrow 506 along the time axis 504, the mobile station 108 via the switching function 142 to transmit the positioning signal. There will exist some probability that the

uplink has become active again before the mobile station sends the positioning signal.

According to sub-alternative b), and referring to Fig. 6, the mobile station 108 is pre-ordered by the MPC 111, as indicated by arrow 168 in Fig. 1b, and at a point of time $t_{preorderMS}$ indicated by arrow 602 along a time axis 604, to transmit the positioning signal a specified time after the uplink becomes inactive, this time to transmit being indicated by arrow 606. This pre-order is sent immediately, i.e., prior to the trigger point occurring, as being detected by the VAD 152. The specified time needs to be defined such that the MPC 111 has enough time to send an order to a number of base stations, such as the base stations 102, 104 and 106, to listen for the positioning pulse. In subalternative b) the mobile station 108 uses a VAD, as represented by the VAD 138, for controlling the switching function 142 at the specified time after the triggering point. This VAD is normally already present in the mobile station 108 for DTX. In Fig. 6 the points of time at which the base stations are ordered and the positioning signal is sent have been indicated by arrows 606 and 608, respectively.

A second main alternative is to use the downlink voice activity as a trigger, e.g. when the downlink voice goes active, such as at the start of the downlink speech spurt 310 in Fig. 3 or in the case illustrated in Fig. 4. The idea is that there is a high probability that the uplink is, or soon will become, inactive. The second main alternative requires a VAD for the downlink in the switch 110, or base station 106, that corresponds to the VAD 138 for the uplink. This method can also be divided into two alternatives corresponding to the above discussed sub-alternatives a) and b). When using sub-alternative b) in the second main alternative, an additional VAD, as VAD 152, is needed in the mobile station 108 for the downlink voice. There will be a small probability in both of the sub-alternatives a) and b) that the uplink voice is still active when the UPP is transmitted.

A third main alternative is to combine the first and

second main alternatives and define the trigger point as the transition of either the uplink trigger point or the downlink trigger point, which ever comes first. Also here the general case illustrated in Fig. 4 applies. This third main alternative can also be divided into two sub-alternatives corresponding to sub-alternatives a) and b), as described above for the first main alternative. The advantage of the third main alternative is that the reaction time to send a positioning pulse is reduced, which will reduce the risk that the uplink voice goes active before the positioning pulse is transmitted.

The embodiments described above with reference to Figs. 1-4 have been based upon the presumption that the positioning signal is sent uplink. However, the above discussion will also apply in case the positioning signal is sent downlink, i.e. from the base stations toward the mobile station. Thus, in this case, there will be defined and detected as a triggering point for the transmission of the positioning signal a downlink voice activity transition point in which the downlink voice becomes inactive and/or an uplink voice activity transition point in which the uplink voice becomes active. Where applicable, this principle will also apply to the embodiments described further below.

A modification of the first main alternative described above is to transmit the positioning pulse immediately if the uplink voice is inactive and use a trigger point if the uplink voice is active, as in the first main alternative.

An advantage with this modification is that there is a more than 50% probability that the positioning pulse is transmitted immediately.

A second main embodiment comprises sending, when the uplink voice is inactive, a positioning pulse either periodically or continuously and sending no positioning pulse when the uplink voice is active. Fig. 7 is a diagram illustrating, with the aid of two time axes 702 and 704 covering the same period of time, voice activity and positioning signal transmission, respectively, in the traffic

channel during uplink communication between the mobile station 108 and the base station 106. Uplink speech spurts 706, 708, 710 and 712 of varying length are indicated along the time axis 702, whereas trains 714, 716, 718, 720 and 722 of positioning pulses, as well as two single positioning pulses 724 and 726 are indicated along the time axis 704. As can be seen, each positioning pulse is indicated by an arrow.

Each of the pulse trains 714-722 appears during a period of time during which the uplink voice is inactive, i.e. before the speech spurt 706, between the speech spurts 706 and 708, between the speech spurts 708 and 710, between the speech spurts 710 and 712 and after the speech spurt 712, respectively. The positioning pulses of each speech spurt can appear continously or with a desired period of T_1

A time-out value T_2 can be used to maximize the time when no positioning pulse is sent, at which the positioning pulse is sent anyway causing a voice disruption. This is indicted during the long speech spurt 710 where the two positioning pulses 724 and 726 appear after this time-out value. This method requires a VAD, such as VAD 138, in the mobile station 108. This VAD will normally be present there for DTX.

In this method it may be advantageous to implement an extra VAD, such as VAD 152 in Fig. 1b, in the MPC 111 for the uplink voice in order to detect when the mobile station 108 is sending the positioning pulse.

Claims

1. A method for determining, in a wireless communication system including a number of base stations (102,104,106) for serving mobile stations (108) present in the system, the position of a mobile station during a voice call in progress by performing time or angle measurements using a positioning signal (222) between the mobile station and a required number of the base stations, **characterized by** detecting voice activity in the voice call in progress and voice synchronizing the transmission of the positioning signal with a part of the voice call in progress having low or lacking voice activity.

2. A method according to claim 1, **characterized by** defining and detecting as a triggering point for the transmission of the positioning signal,

in case the positioning signal is sent uplink, an uplink voice activity transition point in which the upplink voice becomes inactive,

in case the positioning signal is sent downlink, a downlink voice activity transition point in which the downlink voice becomes inactive.

3. A method according to claim 1, **characterized by** defining and detecting as a triggering point for the transmission of the positioning signal,

in case the positioning signal is sent uplink, a downlink voice activity transition point in which the downlink voice becomes active,

in case the positioning signal is sent downlink, an uplink voice activity transition point in which the uplink voice becomes active.

4. A method according to claim 1, **characterized by** defining and detecting as a triggering point for the transmission of the positioning signal the applicable one of the uplink voice activity transition point and the downlink voice activity transition point that comes first.

5. A method according to any of claims 2-4, **characterized by** first ordering listening for the positioning signal and

then ordering transmittance of the positioning signal.

6. A method according to any of claims 2-4, f pre-ordering, before appearance of the triggering point, transmittance of the positioning signal a specified time after the appearance of the triggering point, the specified time being defined to be enough to admit ordering to listen for the positioning signal to enable catching of it when it appears.

7. A method according to any of claims 2-4, **characterized by** first ordering a number of base stations to listen for the positioning signal and then ordering the mobile station to transmit the positioning signal.

8. A method according to any of claims 2-4, **characterized by** pre-ordering the mobile station, before appearance of the triggering point, to transmit the positioning signal a specified time after the appearance of the triggering point, the specified time being defined to be enough to admit ordering a number of base stations to listen for the positioning signal to enable them to catch the positioning signal when it appears.

9. A method according to claim 2, **characterized by** transmitting the positioning signal immediately if the uplink voice is inactive.

10. A method for determining, in a wireless communication system including a number of base stations for serving mobile stations present in the system, the position of a mobile station during a voice call in progress by measuring times for a positioning signal between the mobile station and a required number of the base stations, characterized by detecting voice activity in the voice call in progress and transmitting the positioning signal immediately if the uplink voice is inactive and sending no positioning signal when the uplink voice is active.

11. A method according to claim 10, **characterized by** transmitting the position signal periodically.

12. A method according to claim 10, **characterized by** transmitting the position signal continously.

13. A method according to any of claims 10-12,

characterized by using a time-out value to maximize the time when no positioning signal is sent.

14. Apparatus for determining, in a wireless communication system including a number of base stations (102,104,106) for serving mobile stations (108) present in the system, the position of a mobile station during a voice call in progress by performing time or angle measurements using a positioning signal (222) between the mobile station and a required number of the base stations, **characterized by**

means (138, 152) for detecting voice activity in the voice call in progress and

means (111, 138, 152, 142) for voice synchronizing the transmission of the positioning signal with a part of the voice call in progress having low or lacking voice activity.

15. Apparatus according to claim 14, **characterized by** means (138, 152) for defining and detecting as a triggering point for the transmission of the positioning signal,

in case the positioning signal is sent uplink, an uplink voice activity transition point in which the upplink voice becomes inactive,

in case the positioning signal is sent downlink, a downlink voice activity transition point in which the downlink voice becomes inactive.

16. Apparatus according to claim 14, **characterized by** means (138, 152) for defining and detecting as a triggering point for the transmission of the positioning signal,

in case the positioning signal is sent uplink, a downlink voice activity transition point in which the downlink voice becomes active,

in case the positioning signal is sent downlink, an uplink voice activity transition point in which the uplink voice becomes active.

17. Apparatus according to claims 14, **characterized by** means (138, 152) for defining and detecting as a triggering point for the transmission of the positioning signal the one of the uplink voice activity transition point and the downlink voice activity transition point that comes first.

18. Apparatus according to any of claims 14-17, **characterized by**

means (111) for first ordering listening for the positioning signal and then ordering transmittance of the positioning signal.

19. Apparatus according to any of claims 14-17, **characterized by**

means (111) for pre-ordering, before appearance of the triggering point, transmittance of the positioning signal a specified time after the appearance of the triggering point, the specified time being defined to be enough to admit ordering to listen for the positioning signal to enable catching of it when it appears.

20. Apparatus according to any of claims 14-17, **characterized by**

means (111) for first ordering a number of base stations to listen for the positioning signal and then ordering the mobile station to transmit the positioning signal.

21. Apparatus according to any of claims 14-17, **characterized by**

means (111) for pre-ordering the mobile station, before appearance of the triggering point, to transmit the positioning signal a specified time after the appearance of the triggering point, the specified time being defined to be enough to admit ordering a number of base stations to listen for the positioning signal to enable them to catch the positioning signal when it appears.

22. Apparatus according to claim 15, **characterized by** means (111) for transmitting the positioning signal immediately if the uplink voice is inactive.

23. Apparatus for determining, in a wireless communication system including a number of base stations for serving mobile stations present in the system, the position of a mobile station during a voice call in progress by performing time or angle measurements using a positioning signal between the mobile station and a required number of the base stations, characterized by

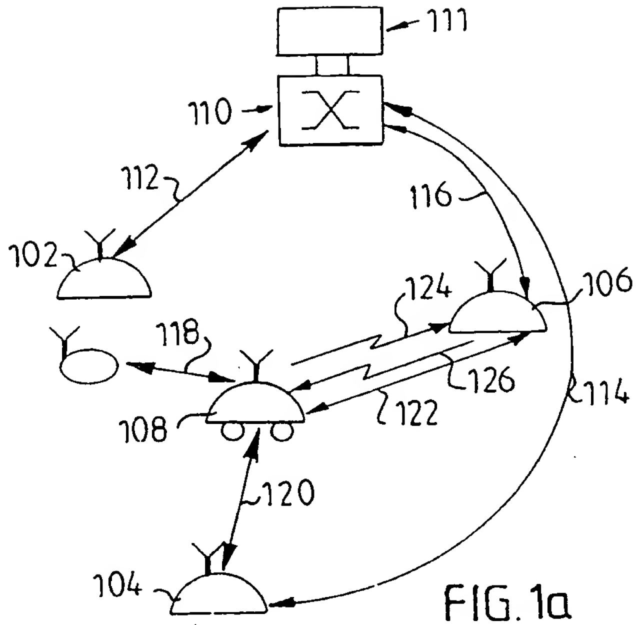
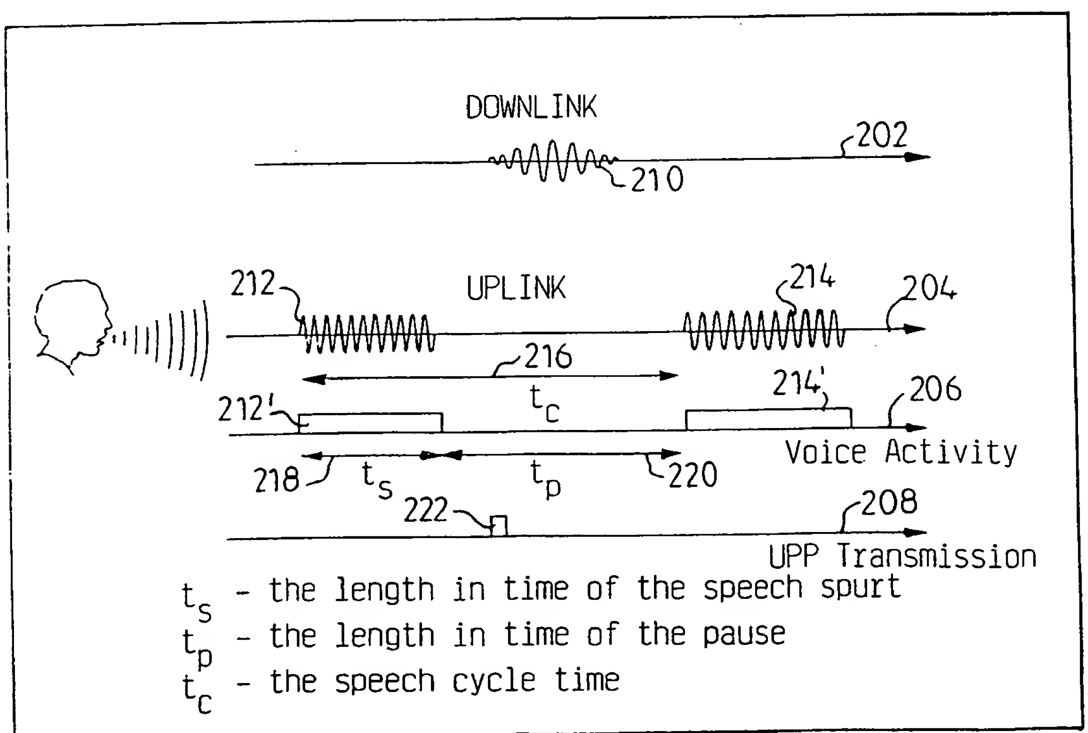


FIG. 1a



VOICE ACTIVITY

FIG. 2

means (138, 152) for detecting voice activity in the voice call in progress and

means (111, 138, 152, 142) for transmitting the positioning signal immediately if the uplink voice is inactive and sending no positioning signal when the uplink voice is active.

24. Apparatus according to claim 23, characterized by means (138, 152) for transmitting the position signal periodically.

25. Apparatus according to claim 23, characterized by means (138, 152) for transmitting the position signal continously.

26. Apparatus according to any of claims 23-25, **characterized by**

means (138, 152) for using a time-out value to maximize the time when no positioning signal is sent.

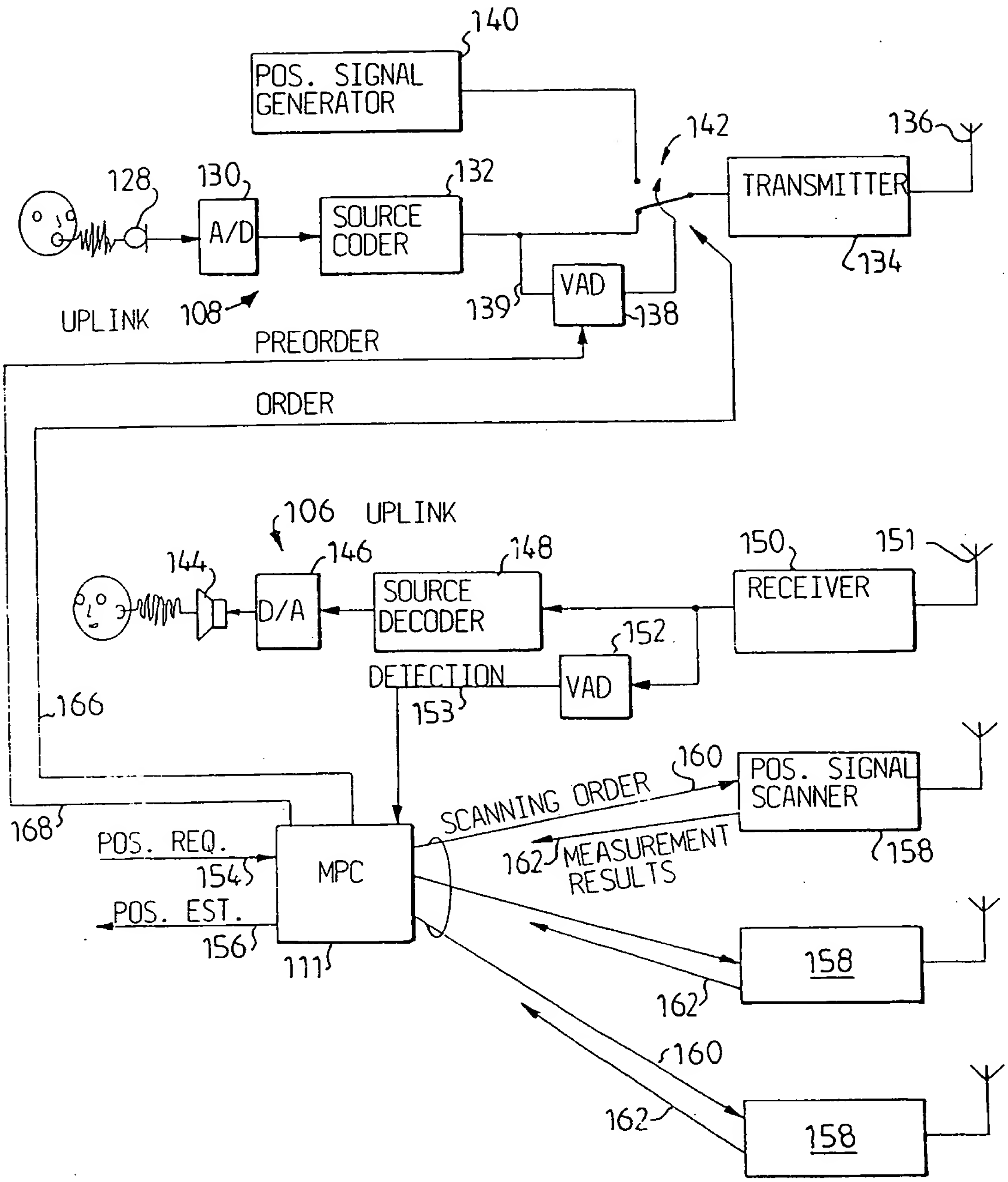

140
POS. SIGNAL GENERATOR
142
136
TRANSMITTER
128
130
132
A/D
SOURCE CODER
134
VAD
139
138
UPLINK
108
PREORDER
ORDER
106
UPLINK
144
146
148
150
151
D/A
SOURCE DECODER
RECEIVER
152
DETECTION
VAD
153
166
160
POS. SIGNAL SCANNER
SCANNING ORDER
168
POS. REQ.
MPC
162
MEASUREMENT RESULTS
158
154
POS. EST.
156
111
158
162
160
162
158

FIG.1b

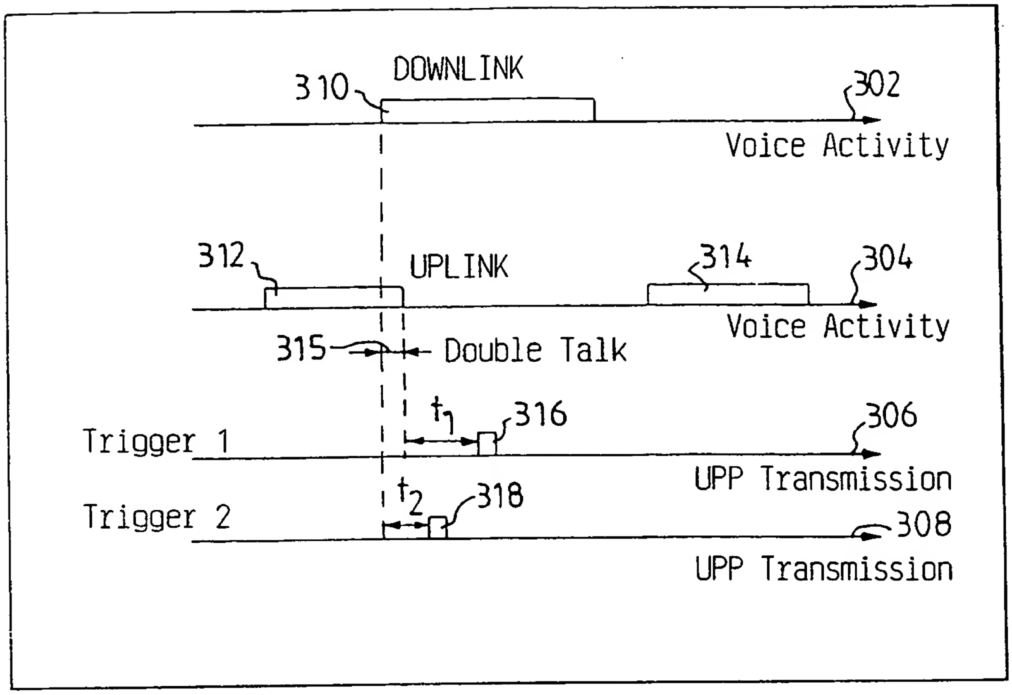


FIG.3 Trigger Points

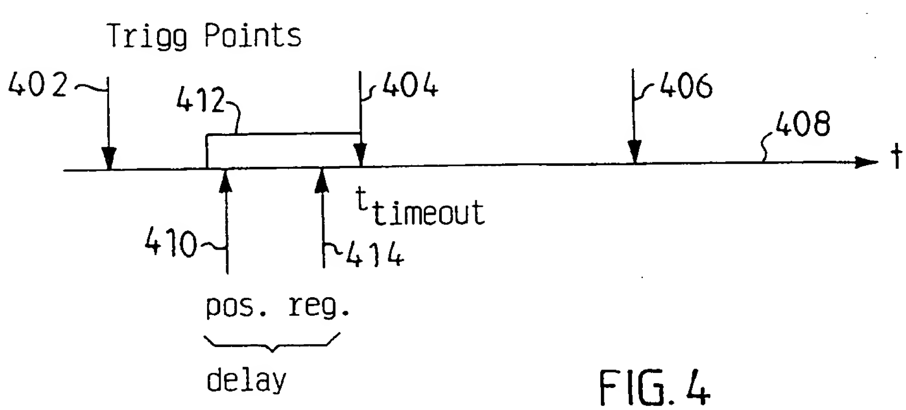


FIG.4

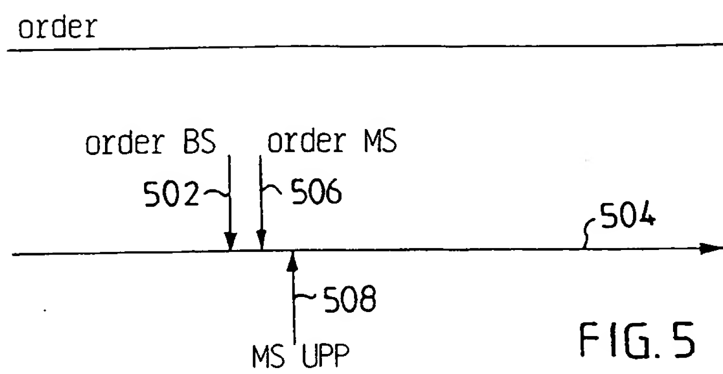


FIG. 5

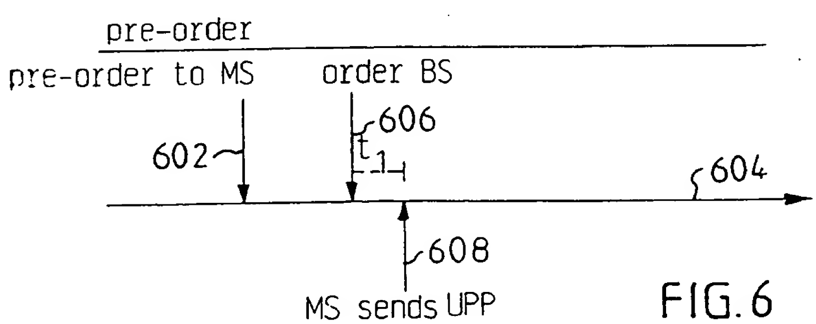


FIG. 6

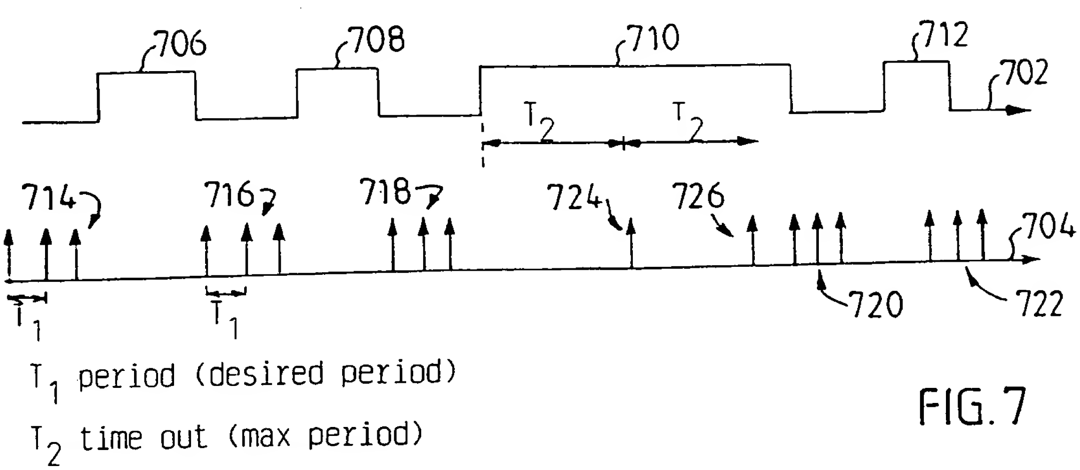


FIG. 7

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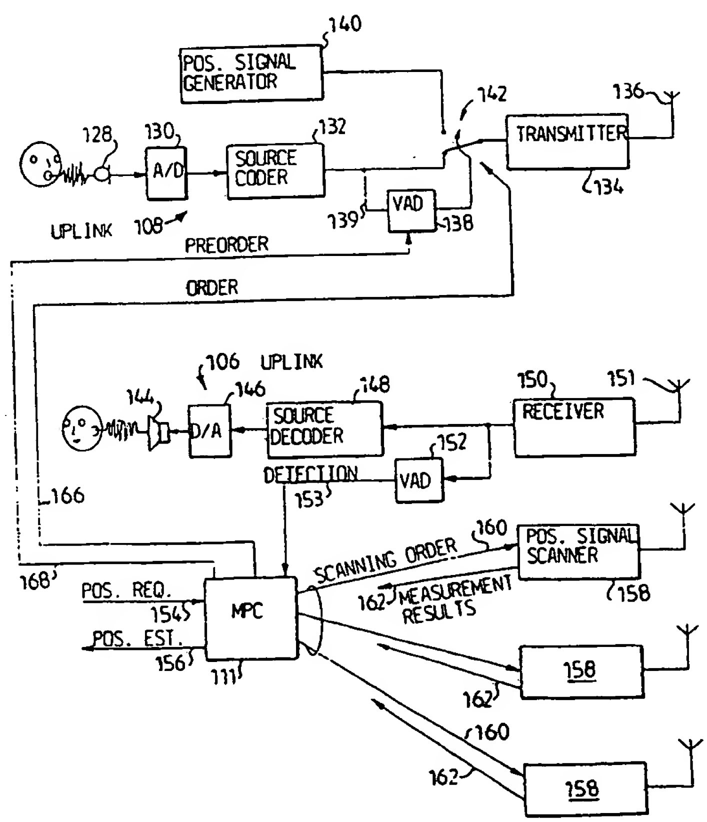
(57) Abstract

In a wireless communication system including a number of base stations (102, 104, 106) for serving mobile stations (108) present in the system, the position of a mobile station during a voice call in progress is determined by performing time or angle measurements using a positioning signal between the mobile station and a required number of the base stations. Means (138, 152) are provided for detecting voice activity in the voice call in progress, and further means (111, 138, 152, 142) are provided for voice synchronizing the transmission of the positioning signal with a part of the voice call in progress having low or lacking voice activity.



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International application No.
PCT/SE 99/00464

A. CLASSIFICATION OF SUBJECT MATTER

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A	WO 9714257 A1 (TRACKMOBILE, INC.), 17 April 1997 (17.04.97), page 3, line 21 - page 10, line 7, abstract --	1-26
A	FR 2753035 A1 (MOTOROLA INC SOCIETE DE DROIT DE L ETAT DU DELAWARE), 6 March 1998 (06.03.98), page 2, line 32 - page 4, line 32 --	1-26
A	WO 9635306 A1 (TELECOM SECURICOR CELLULAR RADIO LIMITED), 7 November 1996 (07.11.96), page 2, line 30 - page 8, line 15 --	1-26

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00464

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A	WO 9747148 A2 (QUALCOMM INCORPORATED), 11 December 1997 (11.12.97), page 5, line 23 - page 6, line 2	1-26

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PCT/SE 99/00464

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